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TITLE: RELATIONSHIPS BETWEEN INDICES OF THE NATURE AND EXTENT OF COMBUSTION IN A BURNING CIGARETTE, PRODUCT DESIGN, AND YIELDS OF MAINSTREAM SMOKE COMPONENTS

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ABSTRACT: Methods have been developed for the determination of indices characterizing the nature and extent of the combustion process in the burning cigarette, with the objective of correlating such indices with cigarette design features and yields of mainstream smoke components. Cigarettes were smoked on a single channel smoking machine and the total mainstream gas phase collected in a storage bag prior to analysis by gas solid chromatography. A Spectra Physics SP4100 computing integrator was used to record the peaks and to determine percentage composition. The integrator was also programmed to calculate three combustion indices from the gas phase composition: (1) the volume of air drawn through the cone during a puff, called precombustion volume, (2) the total volume of carbon oxides produced during a puff, and (3) the carbon monoxide to carbon dioxide ratio (v:v). Combustion indices were determined for series of cigarette types, each series being chosen to display a range of product design features. Changes in combustion indices were correlated with variations in product design and smoking regime and with the delivery per cigarette of carbon monoxide and certain other mainstream smoke components.

REVIEW: The authors measured several compounds in mainstream gas phase and correlated the deliveries of these compounds with three combustion indexes. The compounds --CO, CO_2, total aldehydes, HCN, and formaldehyde--were all determined by GC. The combustion indexes--CO/CO_2, total carbon oxides (CO_x), and precombustion volume--were calculated from the GC data. The precombustion volume is the volume of air drawn directly through the coal during a puff. It was calculated from the N_2 and O_2 levels in the gas phase, assuming all of the O_2 passing through the coal was consumed. The precombustion volume was varied not only by smoking commercial cigarettes with different ventilation levels but also by using three puff volumes: 25, 35, and 50 cm^3. The commercial cigarettes were listed by brand name. An example of some of the results is shown below.

		Combustion Index		
Cigarette	Tar	CO/CO_2	CO_x	Precomb. Vol.
Winston	15 mg	0.56	4.8 cm^3	10 cm^3
Marlboro	16 mg	0.52	4.6 cm^3	10 cm^3
F (not identified)	1 mg	0.25	0.6 cm^3	1.1 cm^3

Increasing the ventilation reduces the precombustion volume. Total carbon oxides and the CO/CO_2 ratio also decrease. Plots of the precombustion volume versus the deliveries of CO, CO_2, CO_x, and HCN gave straight lines. For each gas phase component, all data points fell on the same line regardless whether the precombustion volume was varied by ventilation or by changing the puff volume. Total aldehydes and formaldehyde showed a rapid nonlinear increase with increasing precombustion volume. Other combustion indexes were not as well correlated.

-Reviewed by D. McRae